The usefulness of physiological data as indicator for situation awareness in semi-autonomous driving

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Context

- According to the SAE classification, the next level of automation of future cars will be conditionally automated driving : drivers will be allowed to perform secondary task without monitoring the environment but they still have to be ready to take over control.
- It is important to maintain a high Situation Awareness (SA) of drivers but at this time, a continuous measure of SA does not exist yet.

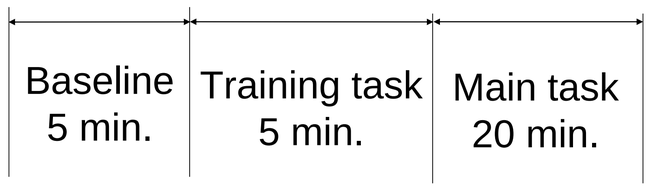
Research Question

Is it possible to evaluate SA using physiological data of drivers during conditionally automated driving ?

Methods

Participants : N = 90 (40M, 49F, 1other), Age = 24.15 (SD = 5.95)

Design and procedure :



Measures :

PSYCHOPHYSIOLOGY

- ECG
- EDA
- Respiration

QUESTIONNAIRES

- SART (Situation awareness)
- NASA-TLX (Cognitive load)
- Subjective ratings of dangerousness level of obstacles

***TAKE-OVER* QUALITY**

- Reaction time (RT)
- Time to understand the situation after TOR

- *Baseline :* Driving task performed by the car, no intervention and no secondary task performed by the participants.
- *Training task* : 3 fake Take-Over Requests **(TOR)** + manual driving.
- *Main task* : Monitor the environment and answer appropriately to take-over requests.

2 conditions : **No Secondary Task (NST)** vs. **Secondary Task (ST)**
Secondary Task = Oral backward counting by step of 2

All participants received 6 TOR during the main task : Logo on the dashboard + audio chime

4 obstacles
2 **False alarms**

Presented in randomized order using **Latin square design**

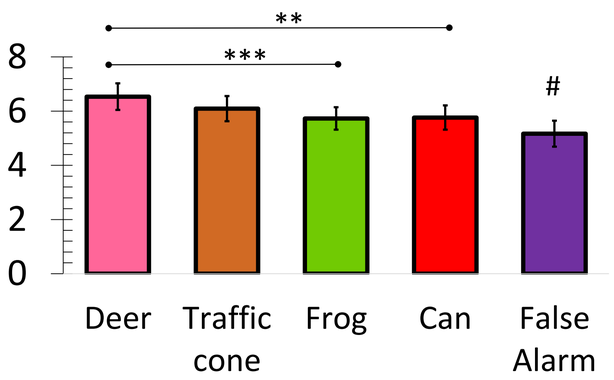
Deer | Traffic cone | Frog | Can

Results

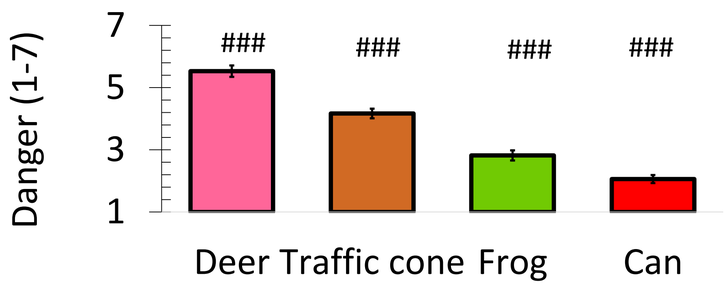
Physiological indicators were calculated from 1 second prior the TOR to 10 seconds after. Each graph show the difference of Interbeat Interval (IBI) and EDA between this short period and the baseline of participants.

*p<0.05 # at least p<0.05 with all obstacle
**p<0.01
*** p<0.001 ### p<0.001 with all obstacle

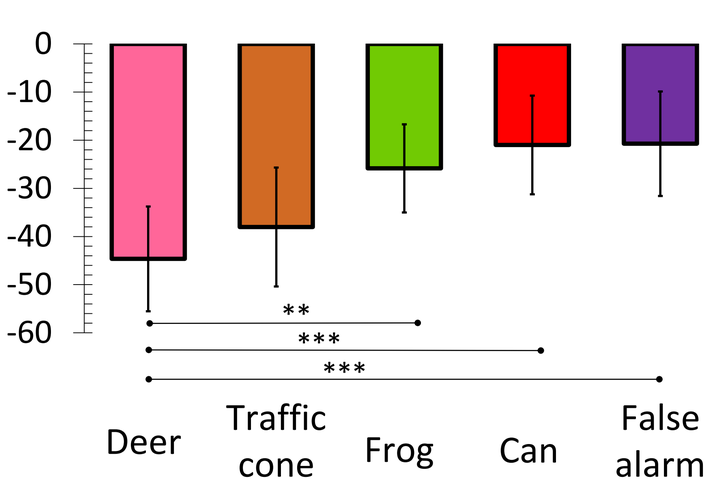
EDA change (µS)



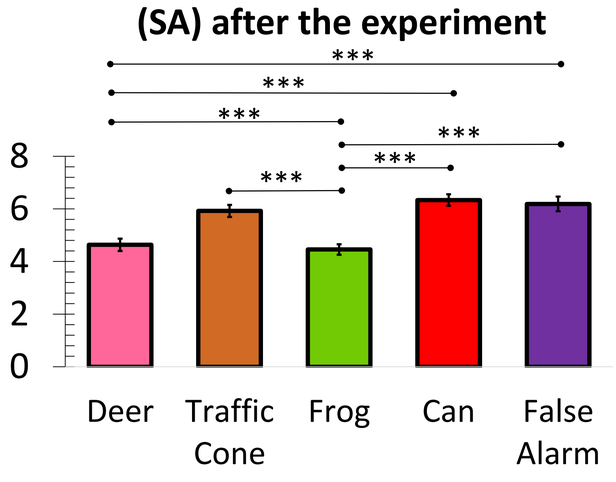
Subjective dangerousness level of obstacles



Interbeat Interval change (ms)



Ratings of Situation Awareness (SA) after the experiment



Discussion and Conclusion

Physiological changes in EDA and IBI are more correlated with the dangerousness level of obstacles than with SA.

For the **Deer** and the **Frog**, physiological changes are higher and ratings of SA are lower, probably due to their movement and unpredictable behavior on the lane.

For further experiment, another approach for manipulating SA will be tested.

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